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## Human Genome Placed on Chip; Biotech Rivals Put It Up for Sale

By ANDREW POLLACK (NYT) 1030 words

The genome on a chip has arrived.

Melding high technology with biology, several companies are rushing to sell slivers of glass or nylon, some as small as postage stamps, packed with pieces of all 30,000 or so known human genes.

The new products will allow scientists to scan all genes in a human tissue sample at once, to determine which genes are active, a job that previously required two or more chips. The whole-genome chips will lower the cost and increase the speed of a widely used test that has transformed biomedical research in the last few years.

"It's sort of a milestone event, very similar to generating an integrated circuit of the genome," said Stephen P. A. Fodor, the chief executive of Affymetrix Inc., the leading seller of gene chips, which are also called microarrays.

Affymetrix, based in Santa Clara, Calif., is expected to announce today that it is accepting orders for its whole-genome chip.

The announcement seems timed to steal some thunder from the rival Agilent Technologies, which is based in nearby Palo Alto. Agilent is to be the host of an analyst meeting today and it plans to announce then that it has started shipping test versions of its whole-genome chip.

Applied Biosystems of Foster City, Calif., a unit of the Applera Corporation, started the race in July with an announcement that it would have a whole-genome chip out by the end of this year. NimbleGen Systems, a small company in Madison, Wis., announced a few days later that it had a genome on a chip that it was not selling but that it was using to run tests for customers.

Gene chips, which detect genes that are active, meaning they are being used to make a protein, have become essential tools. Scientists try to understand the genetic mechanisms of disease by seeing which genes are turned on in, say, a sick kidney or lung compared with those active in a healthy organ. Pharmaceutical companies look at gene activity patterns to try to predict the effects of drugs.

Scientists have found that tumors that look the same under the microscope can differ in terms of which genes are active. So studying gene patterns could become a way to discriminate between deadly and not-so-deadly tumors, or to predict which drug will work best for a particular patient.

Still, even some vendors conceded that the change from two chips to one is more symbolic than revolutionary.

"You can do just as good science with two chips, it costs you a little more," said Roland Green, the vice president for research and development at NimbleGen.

Some scientists questioned whether the chips really have all human genes, because the exact number and identities of all the genes is not known.

The advent of the genome on a chip is, however, evidence that biotechnology, to the extent that it uses electronics, is experiencing some of the rapid progress that has made semiconductors and computers continuously cheaper and smaller.

"One of the effects everyone is looking for in the genomics area is Moore's law -- more data, less money," said Doug Dolginow, an executive vice president at Gene Logic, which sells data from gene chip studies to pharmaceutical companies. "This is a step in that direction."

Moore's law states that the number of transistors on a semiconductor chip doubles every 18 months.

Affymetrix's gene chips are, in fact, made with the same techniques used to make semiconductor chips. In the mid-1990's, the company came out with a set of five chips covering what was then known of the human genome. After the human genome sequence was virtually completed in 2000, the company developed a two-chip set with all the known genes. Now it has the single chip, which some scientists say will be more convenient.

"We like to be able to look at all genes at one time to get a global view of what's going on," said John R. Walker, who runs gene chip operations at the Genomics Institute of the Novartis Research Foundation in San Diego.

Costs should also be lower. Gene chips have been so expensive that many academic scientists still make their own rather than buy them. Affymetrix said it would sell its whole-genome chips for \$300 to \$500 each, depending on volume, little more than half the price of the two-chip set. The other companies have not announced prices.

For Affymetrix, a successful whole-genome chip "is essential for them to maintain their dominance" of high-end microarrays, said Edward A. Tenthoff, an analyst at U.S. Bancorp Piper Jaffray. Affymetrix had total product sales in 2002 of about \$250 million, and a company spokesman said that human genome chips are its top-selling product.

Mr. Tenthoff, who recommends Affymetrix stock, said the company's sales growth rate had moderated as it faces tougher competition. Agilent, a spinoff of Hewlett-Packard that makes its gene chips by printing DNA components onto glass slides using ink jet printers, has gained share, he said. Applied Biosystems, the largest maker of genomics equipment over all, will be

entering the microarray segment of the business with its whole-genome chip, emphasizing the connection of that product to the others it offers, including the gene database developed by its sister company, Celera Genomics.

Jeffrey Trent, scientific director of the Translational Genomics Research Institute in Phoenix, said that while whole-genome chips are useful for medical discovery, the biggest growth of the market will be for chips that can be used by doctors to do diagnoses. And whole-genome chips are too cumbersome for that, he said. Rather, once scientists use the whole-genome chips to find particular genes that are associated with, say, tumor aggressiveness or drug effectiveness, he said, they will then make smaller and cheaper chips containing just those genes for use in diagnosis.